

White Roofs to Cool your Building, your City and
(this is new!) Cool the World

Greenbuild Acceptance Talk
November 14, 2012

Arthur H. Rosenfeld, Former Commissioner
California Energy Commission.

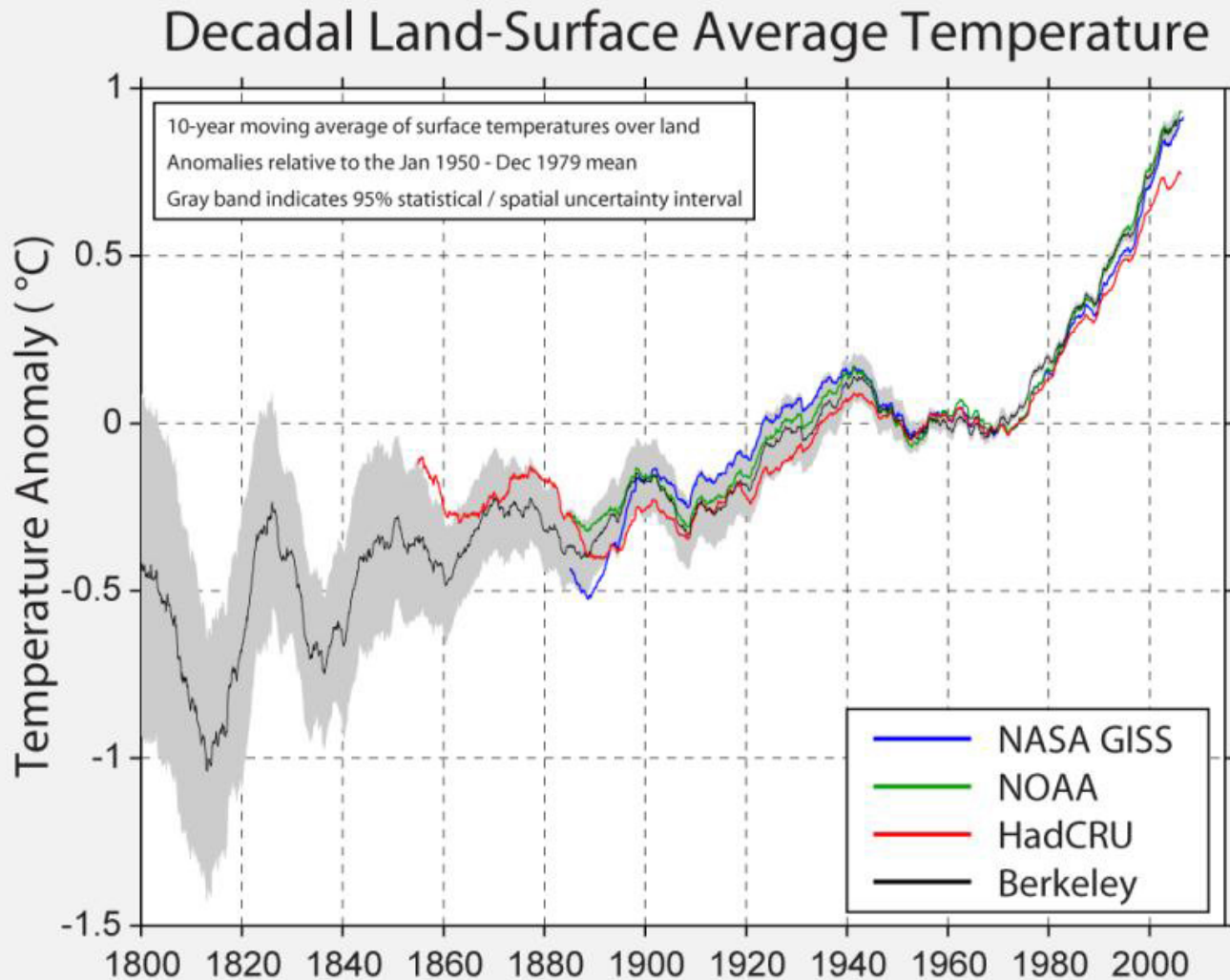
Distinguished Scientist Emeritus
Lawrence Berkeley National Lab.

AHRosenfeld@LBL.gov

510 495-2227

Presentation available at www.ArtRosenfeld.org

Berkeley Earth Surface Temperature Project



preprints and merged data now online at www.BerkeleyEarth.org

Richard Muller
Robert Rohde
Judith Curry
Donald Groom
Bob Jacobsen
Saul Perlmutter
Arthur Rosenfeld
Charlotte Wickham
Jonathan Wurtele

executive director:
Elizabeth Muller

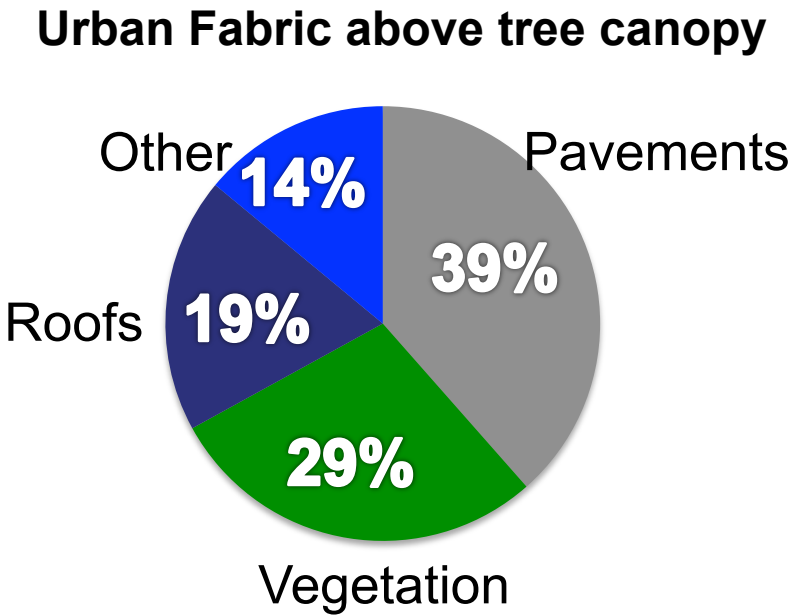
special advisor:
David Brillinger

Novim, U. Calif. Berkeley,
Lawrence Berkeley Lab,
Georgia Tech, Oregon
State



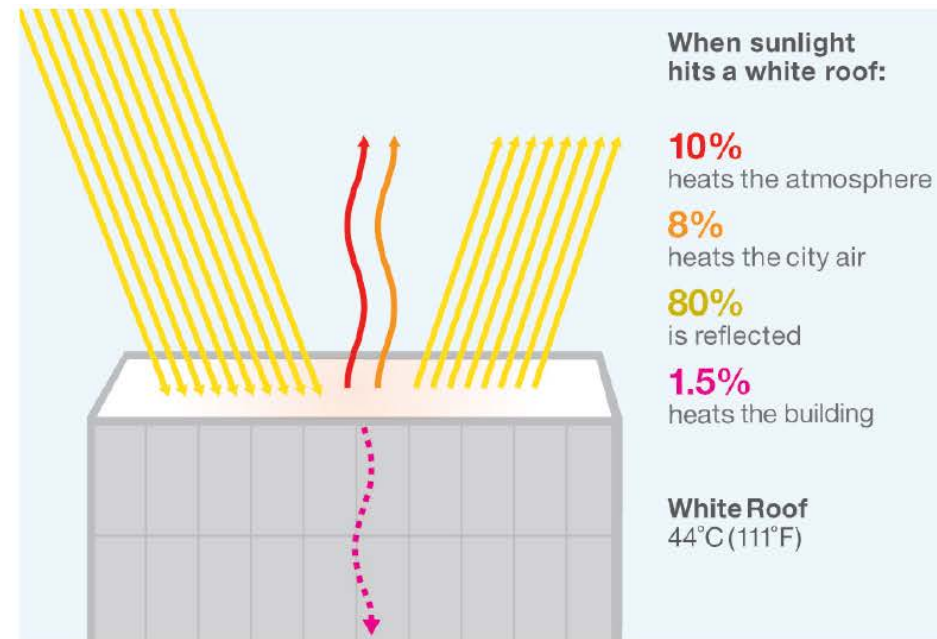
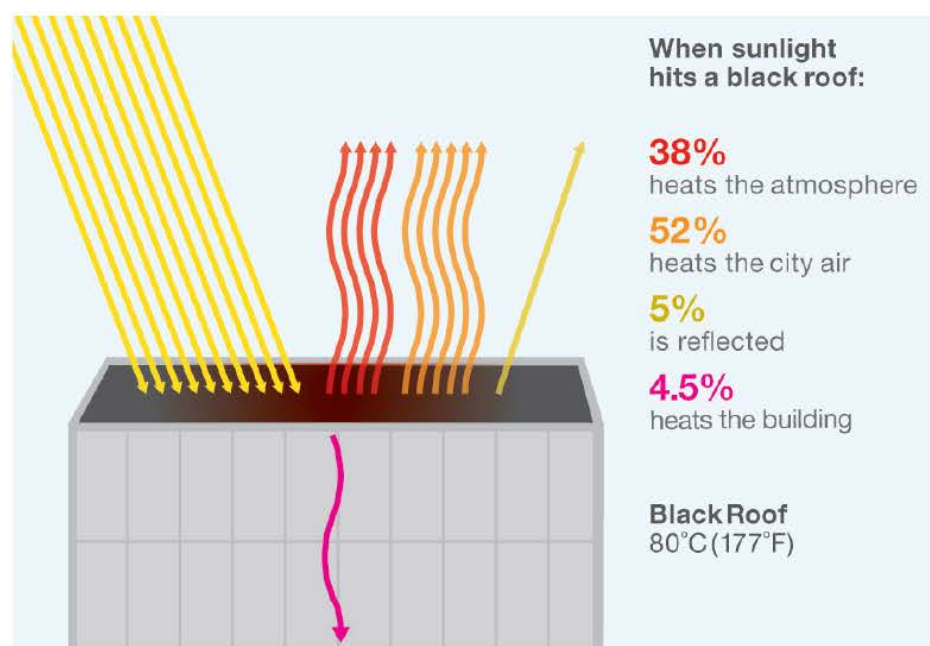
Especially in cities, thanks to the urban heat island effect

- Human activity, combined with dark roofs and pavements, make cities hotter than surrounding rural areas.
- Higher temperatures lead to greater energy use, lower air quality, and a reduced quality of life in urban areas.



Black vs. White Roofs

- Comparison on an August afternoon in Sacramento, CA, when air temperature was about 100°F:



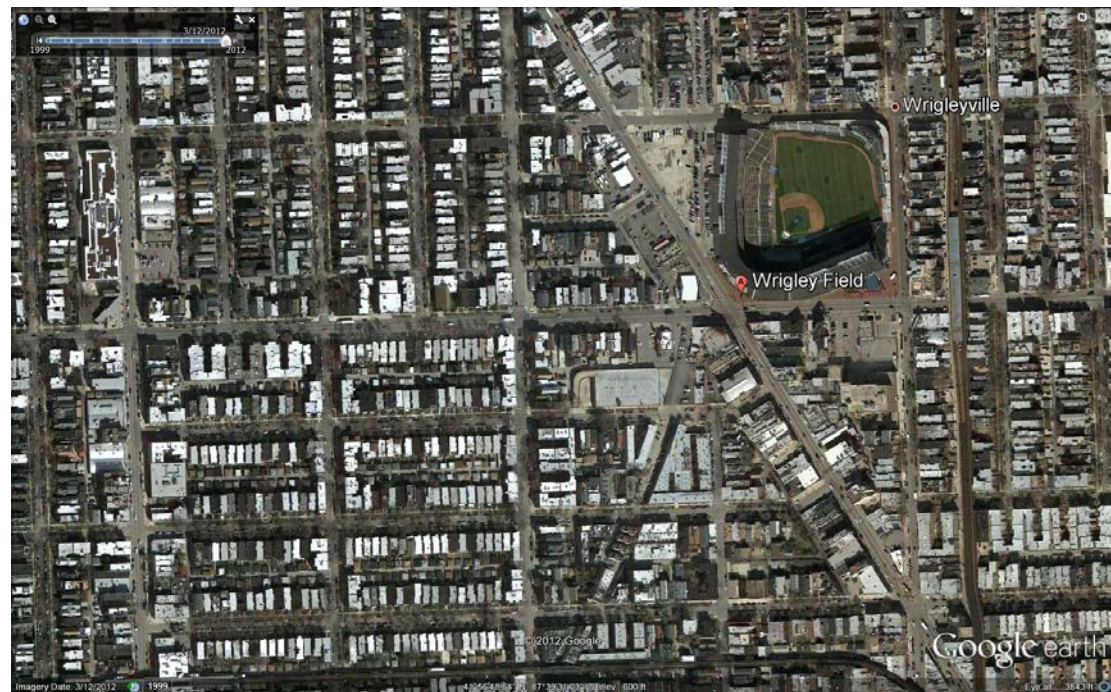
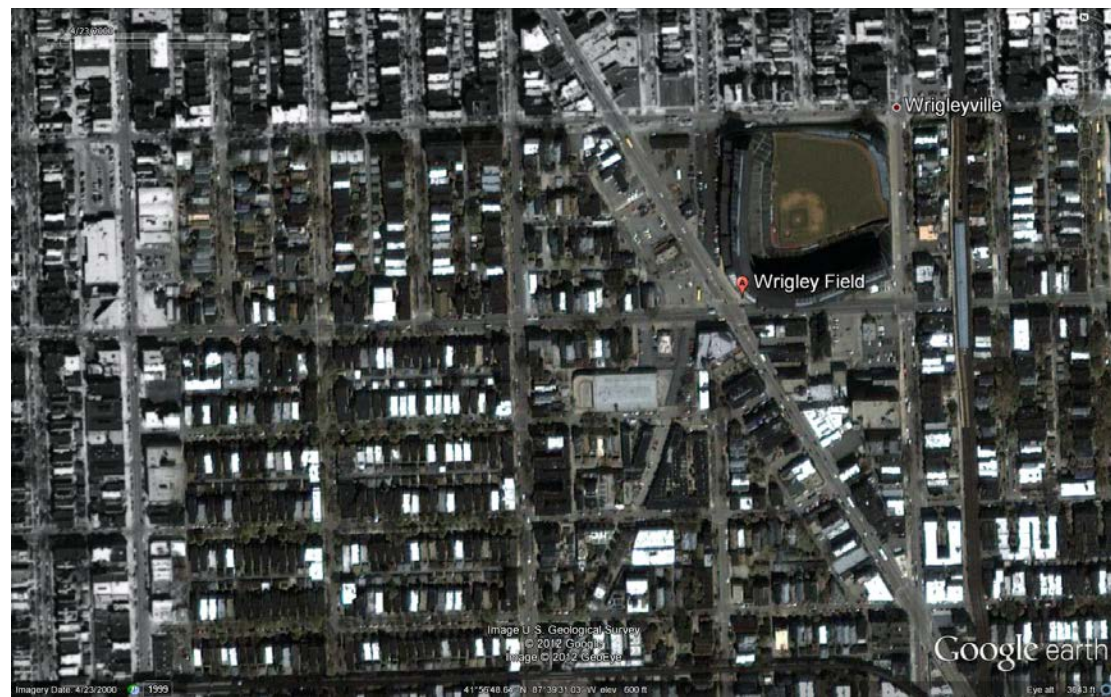
A new white roof (right) absorbs about 80 percent less sunlight than a black roof (left).

Outside air temperature: 37°C (99°F)

2000

1995:

Chicago Heat Wave
739 **reported** deaths
The highest risk group
lived on the
top floors of buildings
with black roofs

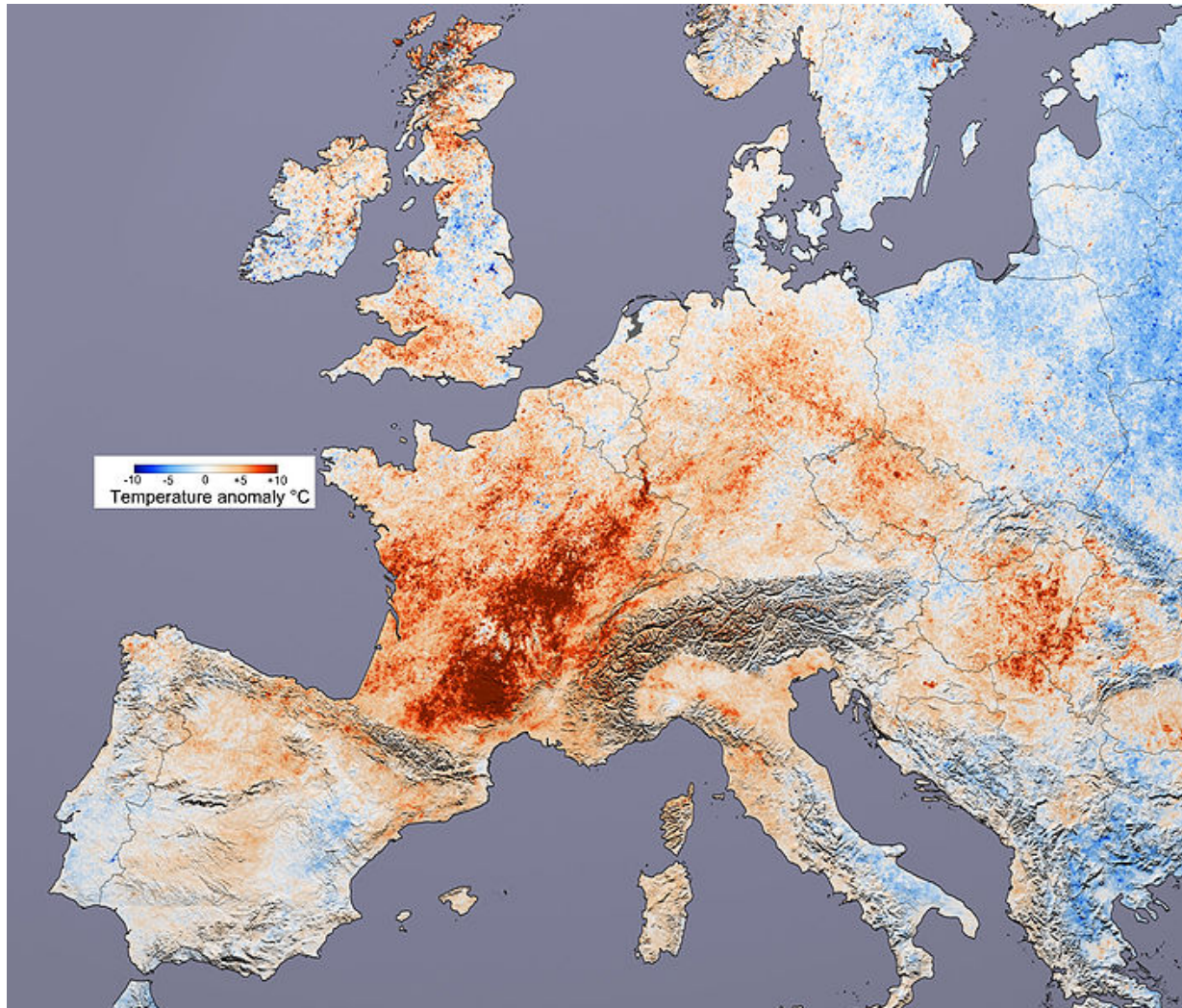


2012

Aug. 2003: European heat wave

Temperature anomalies reached 10°C

52,000 Europeans died—18,000 Italians (2006 assessment)



Country	Fatalities
Italy	18,257
France	14,802
Germany	7,000
Spain	4,130
England & Wales	2,139
Portugal	2,099
Smaller countries	4,025
Total of above	52,452

Art's Epiphany

2003 European Heat Wave

- CEC Energy Efficiency Committee was responsible for Title 24, and I chaired the Committee; a real opportunity to convince T-24 team that “flat roofs shall be white”
- CA Title 24—Building Energy Efficiency Standards
 - Covers new buildings and major retrofits
- CEC adopted white roof requirement for flat roofs in 2005, effective 2007
- Compliance seems ok, and installations of white roofs are running millions of square feet PER MONTH

What about green roofs?

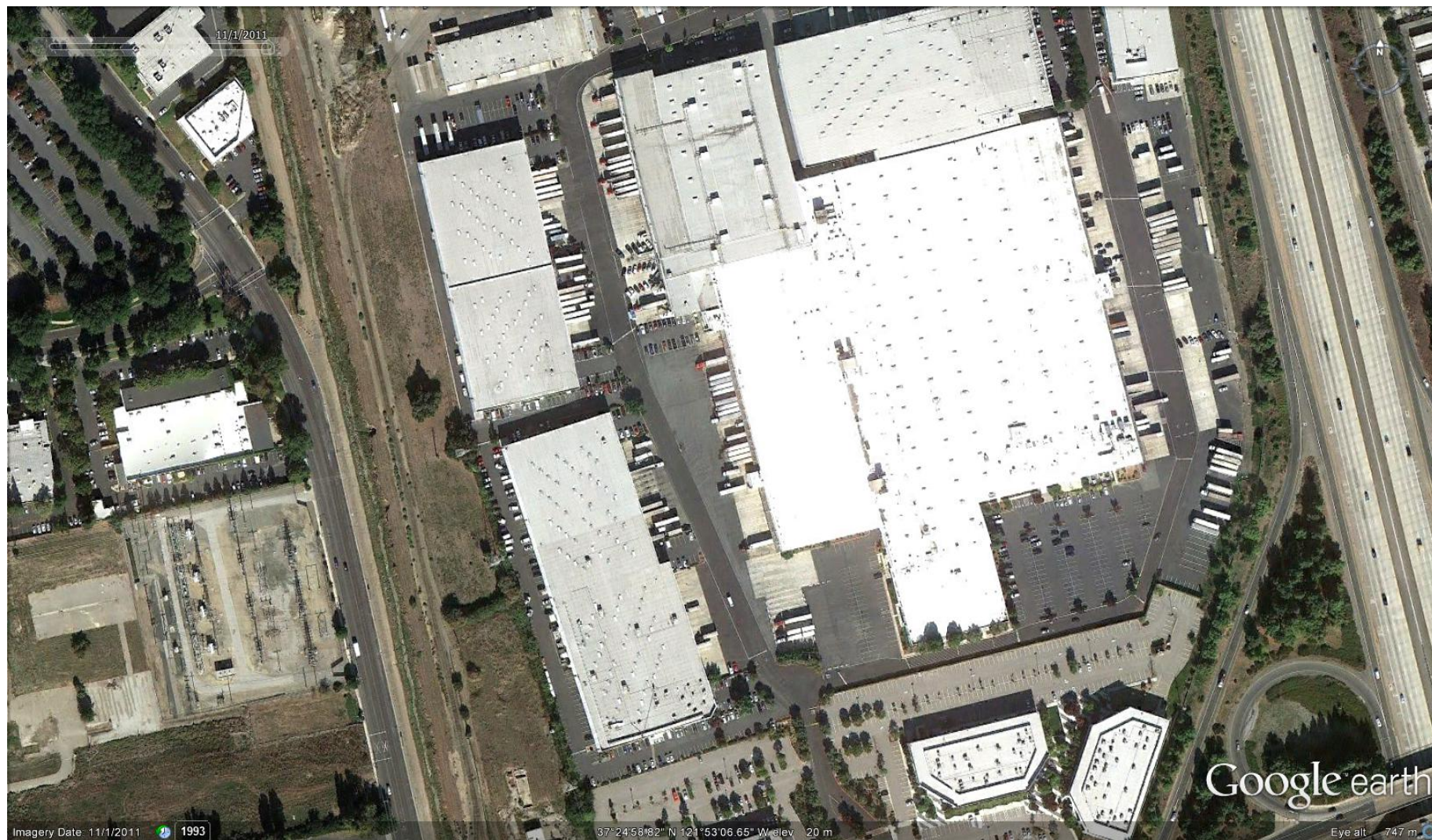
(i.e. vegetated roofs)

- Green roofs automatically comply with T-24 as “cool roofs”
- NYC and Chicago have adopted exactly CA’s regulations for white roofs and of course are actively promoting green roofs
- Green roofs reduce building heat load and mitigate urban heat island effect just as well as white roofs
 - *Caveats:*
 - Per square foot, they are only 1/3 as effective at offsetting global warming as white roofs
 - I don’t promote green roofs for CA or any climate with no rain in the summer

San Jose, CA – 1993

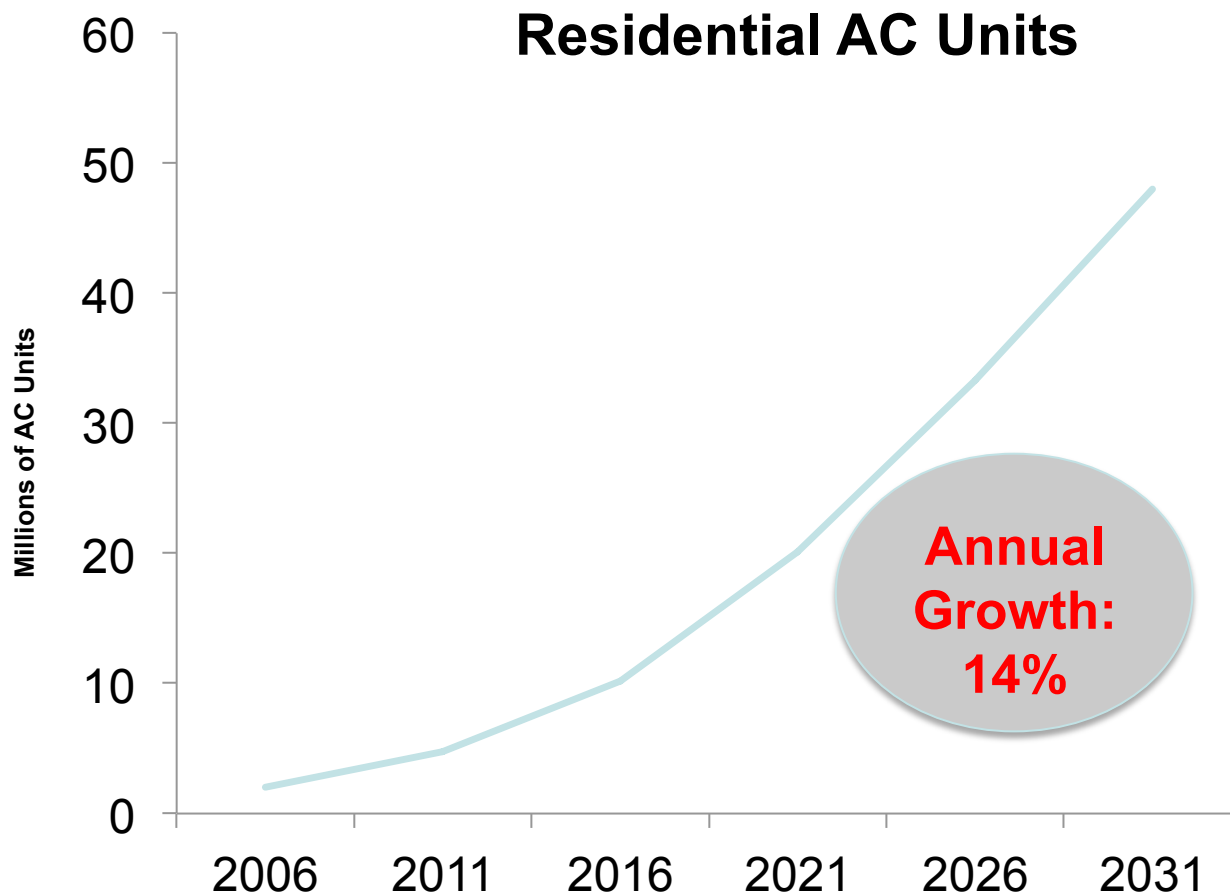


Progress: San Jose, CA – 2011



Cooling our planet

New AC Load: India



GLOBAL COOLING: whitening 100 m² (~1000 ft²) of dark roofing cancels out the **emission** of 10 t of CO₂



How much CO₂ equivalent is offset if we whiten all eligible urban flat roofs world-wide? (i/ii)

- Answer: **24 Gigatonnes (Gt)**
 - 2/3 of a year's worldwide emission
 - Gigatonne = billion metric tons
- If implemented over 20 years (the life of a roof or a program) this is \approx 1.2 Gt/year.

How much CO₂ equivalent is offset if we whiten all eligible urban flat roofs world-wide? (ii/ii)

- Offset is equivalent to **taking half the cars in the world off the road for 20 years.**
 - There are about 600 million passenger cars world wide, and they each emit $\approx 4 \text{ t CO}_2/\text{year}$.



In terms of avoided power plants

- Full white roof potential avoids 500 medium-sized coal fired power plants or 1,000 medium-sized gas fired power plants
- For comparison, global power plants emit annually ~15 Gt CO₂, equivalent to the output of 6,000 typical midsized power plants (2/3 coal, 1/3 gas)
- Further comparison – the real avoided emissions from global CFL deployment is equivalent to 400 power plants.

How to promote white as the color for flat roofs?

Enter Global Cool Cities Alliance—GCCA

- Public-private partnership launched in 2009 thanks to the contagious enthusiasm of DoE Secretary Steve Chu
- Two targets—domestic & international
- Strategy: work with building code officials to require and enforce “Flat roofs shall be white”
- Int’l diplomacy: GCCA is “implementing agent” of Cool Roof and Pavement working group of the G-20 Energy Ministers
 - India, Japan, Mexico, and U.S. have signed up
- “100 Cool Cities” program open to **all** large cities
 - U.S.: Chicago, NYC, Philadelphia, San Jose
 - Abroad: Athens, Mexico City, New Delhi, Sao Paolo, Taipei
- Visit www.GlobalCoolCities.org so your city, company, or public interest group can join



Contact Information

Kurt Shickman

Executive Director

Global Cool Cities Alliance

kurt@globalcoolcities.org

GlobalCoolCities.org / CoolRoofToolKit.org

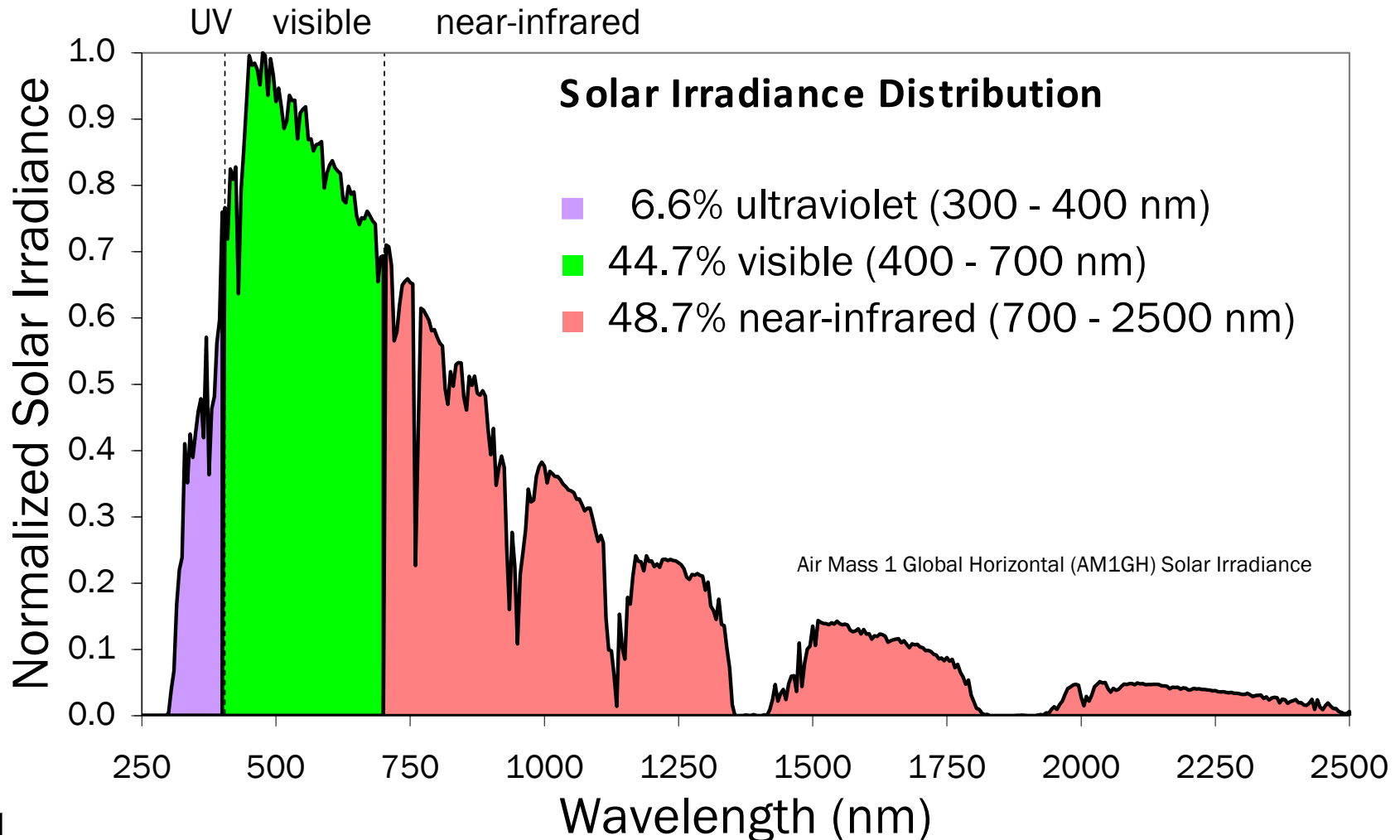
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Resources on the web

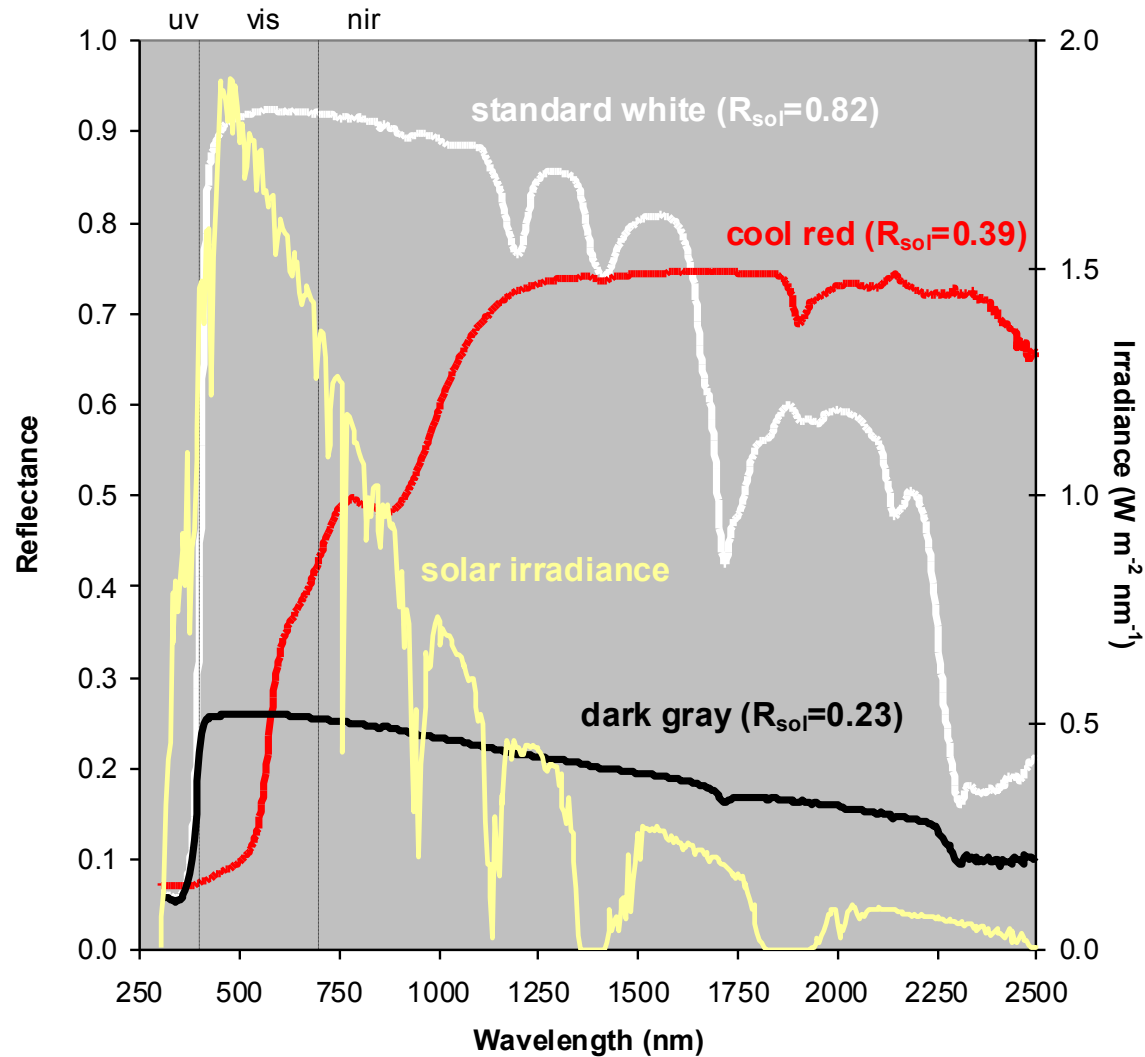
- **LBNL – Heat Island Group**
 - HeatIsland.LBL.gov
- **Art Rosenfeld's website**
 - www.ArtRosenfeld.org
- **Global Cool Cities Alliance**
 - www.GlobalCoolCities.org
- **Cool Roofs and Cool Pavements Toolkit**
 - www.CoolRoofToolkit.org

SUPPLEMENTARY SLIDES

Sunlight — more than meets the eye



White, cool color, warm color



white roof



cool red roof



gray roof

Cool colored roofs available today

<p>cool concrete tile SR ≥ 0.40</p> <p>standard concrete tile (same color)</p>	R=0.41	R=0.44	R=0.44	R=0.48	R=0.46	R=0.41
	black	blue	gray	terracotta	green	chocolate
	R=0.04	R=0.18	R=0.21	R=0.33	R=0.17	R=0.12
solar reflectance gain =	+0.37	+0.26	+0.23	+0.15	+0.29	+0.29

Courtesy
American
Rooftile
Coatings

cool clay tile
SR ≥ 0.40

Courtesy
MCA Clay Tile



Concord Green 81214 57.3 (91.4)	State Gray 81208 39.7 (9.5)
Reefside 81216 57 (97)	Bright Red 81216 38.5 (98.5)
Siena Tan 81217 58.8 (97.5)	Brick Red 81216 38.8 (94.7)
Pearl Gray 81204 45.7 (91.5)	Medium Bronze 81211 34.8 (12)
Marine Green 81052 41 (91.8)	State Blue 81206 34.4 (91.3)
Patina Green 81205 41 (99.2)	State Bronze 81075 30.8 (9.8)

cool metal
SR ≥ 0.30

Courtesy
BASF Industrial
Coatings



cool fiberglass asphalt shingle
SR ≥ 0.25

Courtesy
Elk Corporation